

# Oil and Gas Development: Evaluating the Health Implications

April 13, 2017

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# URD is an Industrial Process



*Drilling in Garfield County*



*Hydraulic fracturing in Garfield County*



*Flowback in Garfield County*



*Seven well pad in Greeley*

# Potential Environmental Stressors (Witter et al 2013)

- Air quality
- Water quality
- Traffic
- Noise, Light, and Vibrations
- Economic conditions
- Social conditions
- Health infrastructure
- Accidents/malfunction

# Oil and Natural Gas Operations



- Can emit air pollutants:
  - Directly
  - Diesel Engines
  - Ozone precursors
- Water Pollutants
  - Spills
  - Leaks

Helmig et al. 2014; McKenzie et al 2014; Halliday et al. 2016;

Halliday\_et\_al-2016-Journal\_of\_Geophysical\_Research\_\_Atmospheres - PDF Architect 2

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**AGU PUBLICATIONS**

**Journal of Geophysical Research: Atmospheres**

**RESEARCH ARTICLE** Atmospheric benzene observations from oil and gas production in the Denver-Julesburg Basin in July and August 2014

10.1002/2016JD025327

**Key Points:**

- Unexpectedly high benzene mixing ratios were observed in Colorado's Wattenburg Gas Field in July and August 2014.
- Oil and natural gas extraction activities are implicated as the primary source for the high benzene observations.
- Gas field measurements of VOCs put a spatial constraint on the location of the gas field benzene source.

**Supporting Information:**

- Supporting Information S1

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**Citation:**  
Halliday, H. S., A. M. Thompson, A. Wisthaler, D. B. Blake, R. S. Hornbrook, T. Mikoviny, M. Müller, P. Eichler, E. C. Apel, and A. J. Hills (2016), Atmospheric benzene observations from oil and gas production in the Denver-Julesburg Basin in July and August 2014, *J. Geophys. Res. Atmos.*, **121**, 11,055–11,074, doi:10.1002/2016JD025327.

Received 11 MAY 2016  
Accepted 9 AUG 2016  
Accepted article online 13 AUG 2016  
Published online 20 SEP 2016

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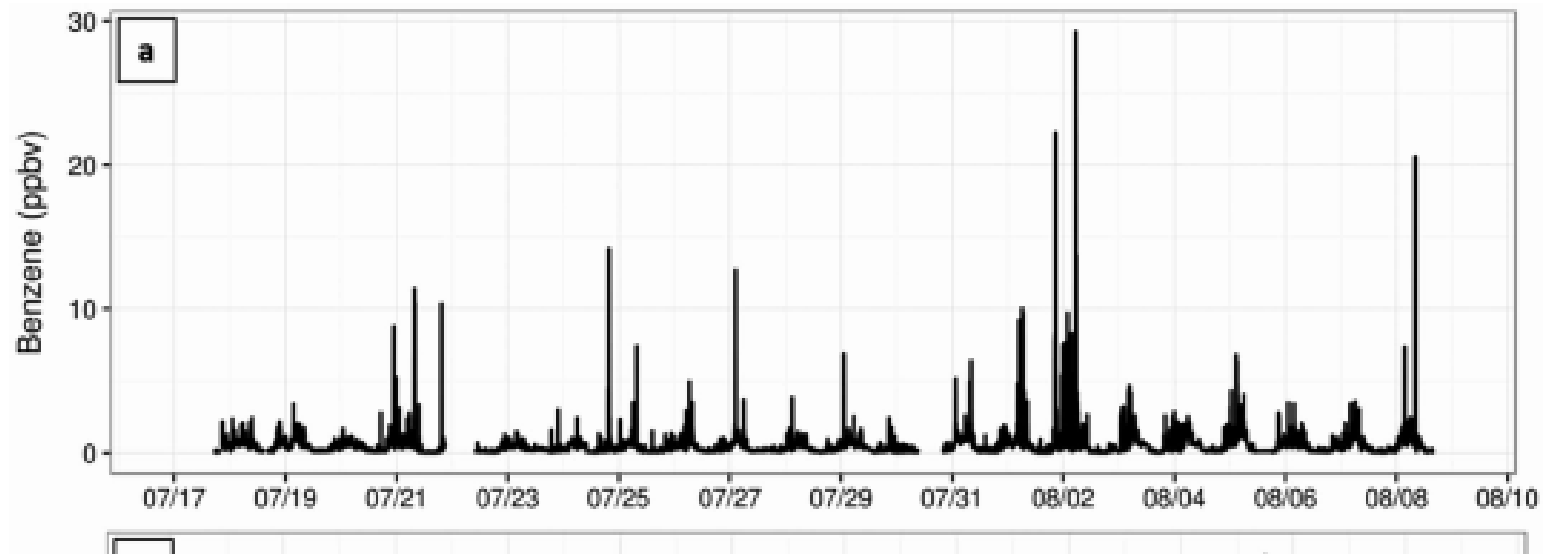
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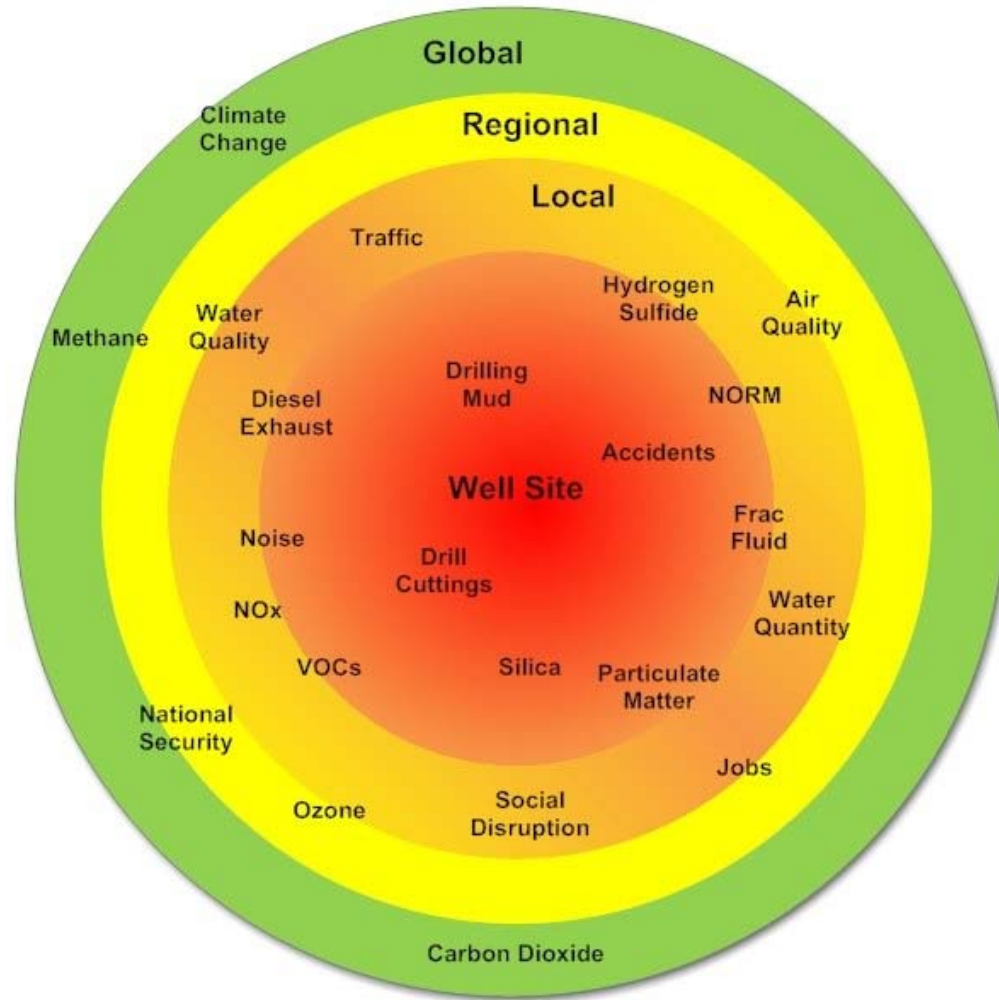
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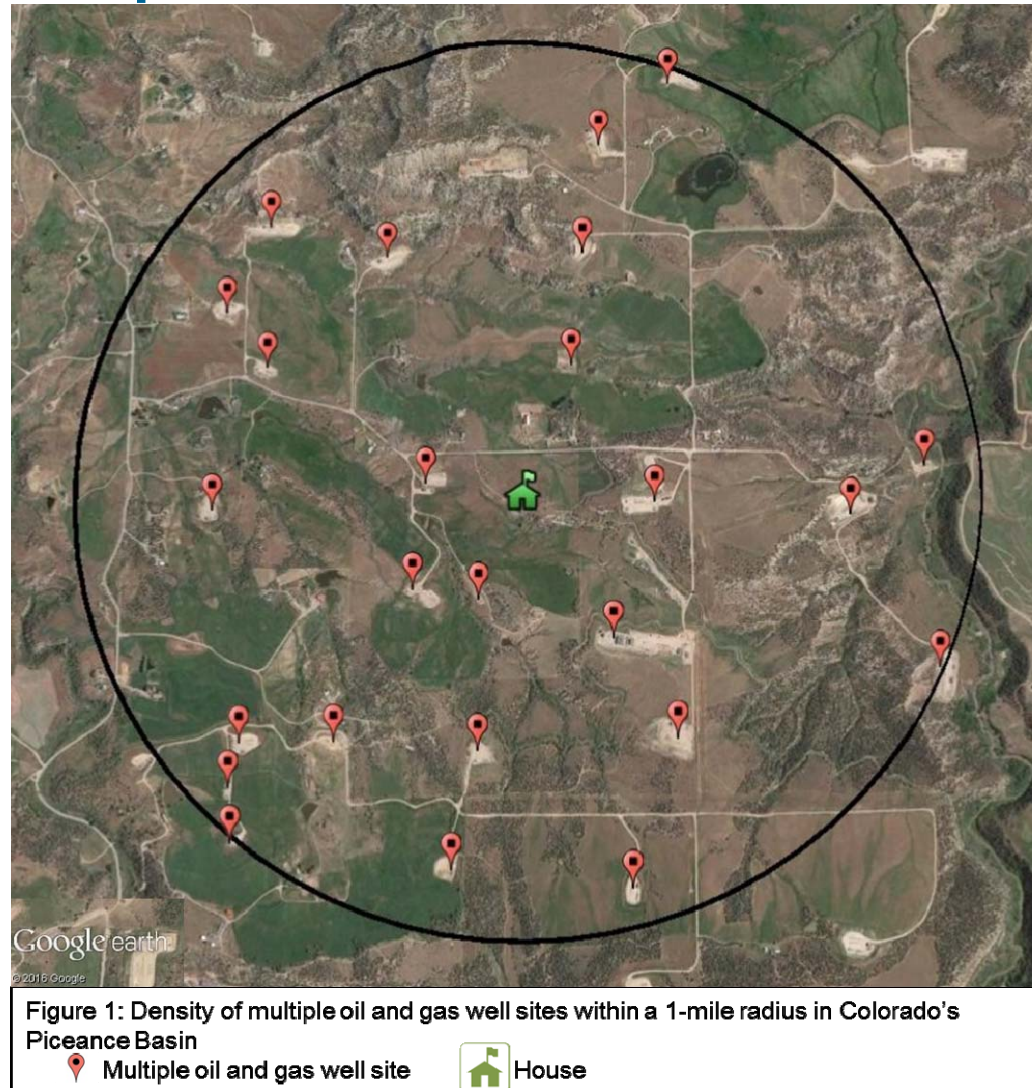
# Repeated peak exposure potentials at night, before sunrise



# Scale of Exposure

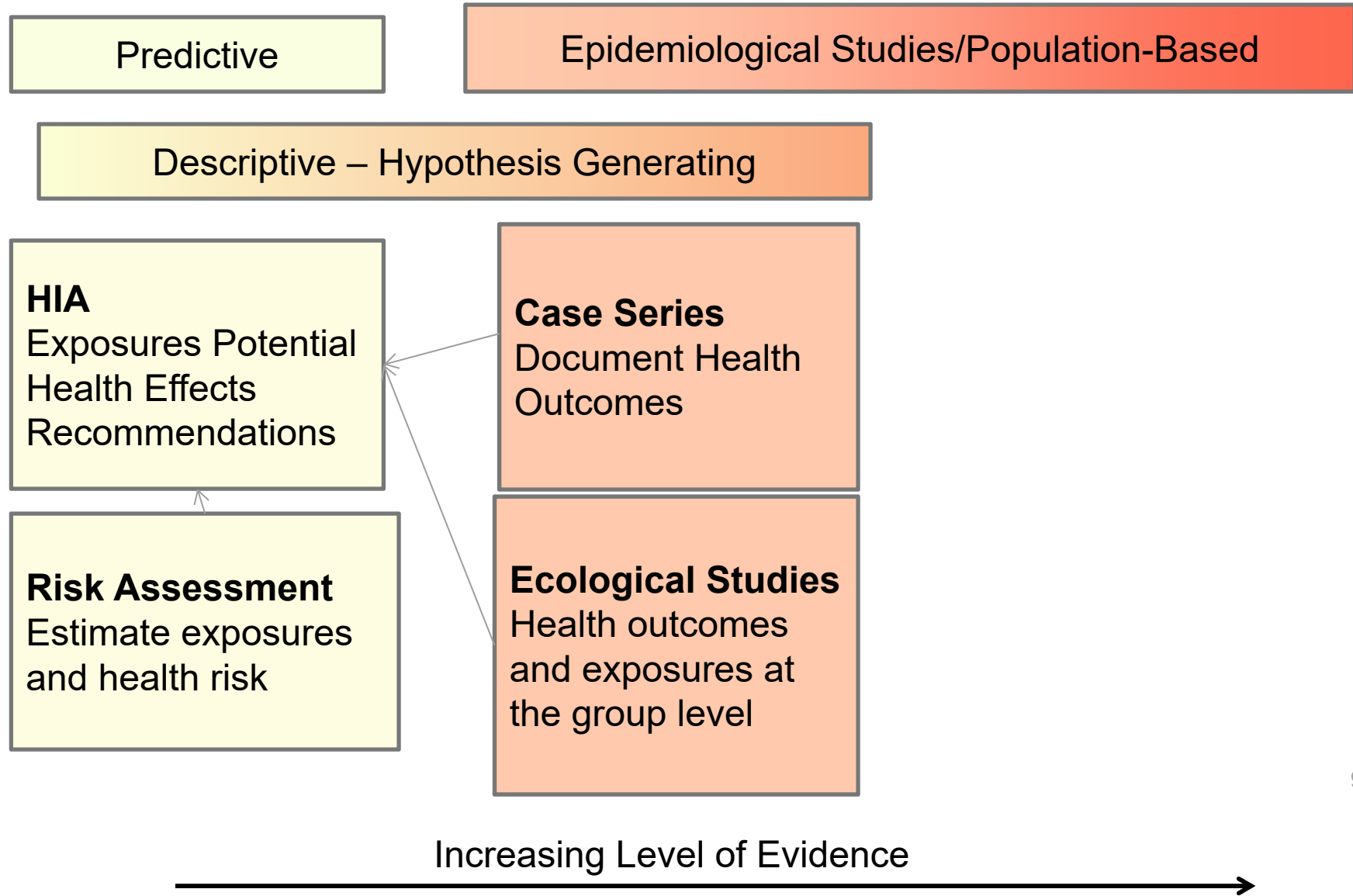


# Scale of Exposure





# Public Health Studies: Level of Evidence



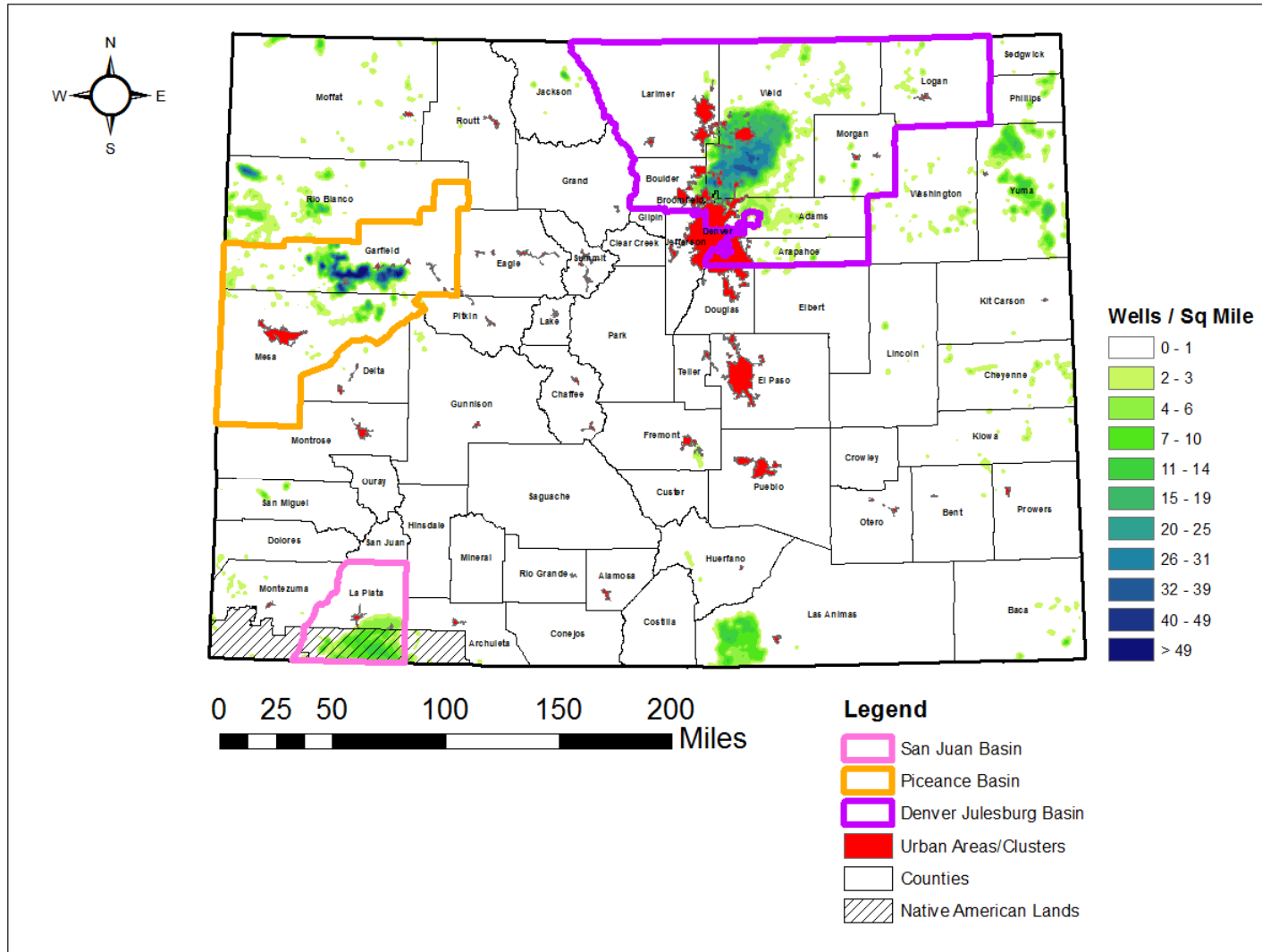
# Conclusions from predictive and descriptive health studies

- People living nearest to the well pads may be at increased risk for neurologic, developmental, endocrine system, and respiratory health effects, as well as cancer and stress.
  - Inventories of chemicals used on O&G sites (Colburn et al. 2012, Ellison et al. 2016)
  - Chemical concentrations in air samples collected in Garfield County (McKenzie et al 2012)
  - Survey of self-reported symptoms (Steinzor et al. 2013, Ferrar)
  - Human cell lines exposed to water samples from O&G areas (Kassotis 2014)
- Risk for exposures and health effects is greatest during the period of short-term, high air emissions that may occur during events such as during well-completions (McKenzie et al. 2012) and well unloadings (Allen et al. 2013) and may be higher at night (Halliday et al. 2016).

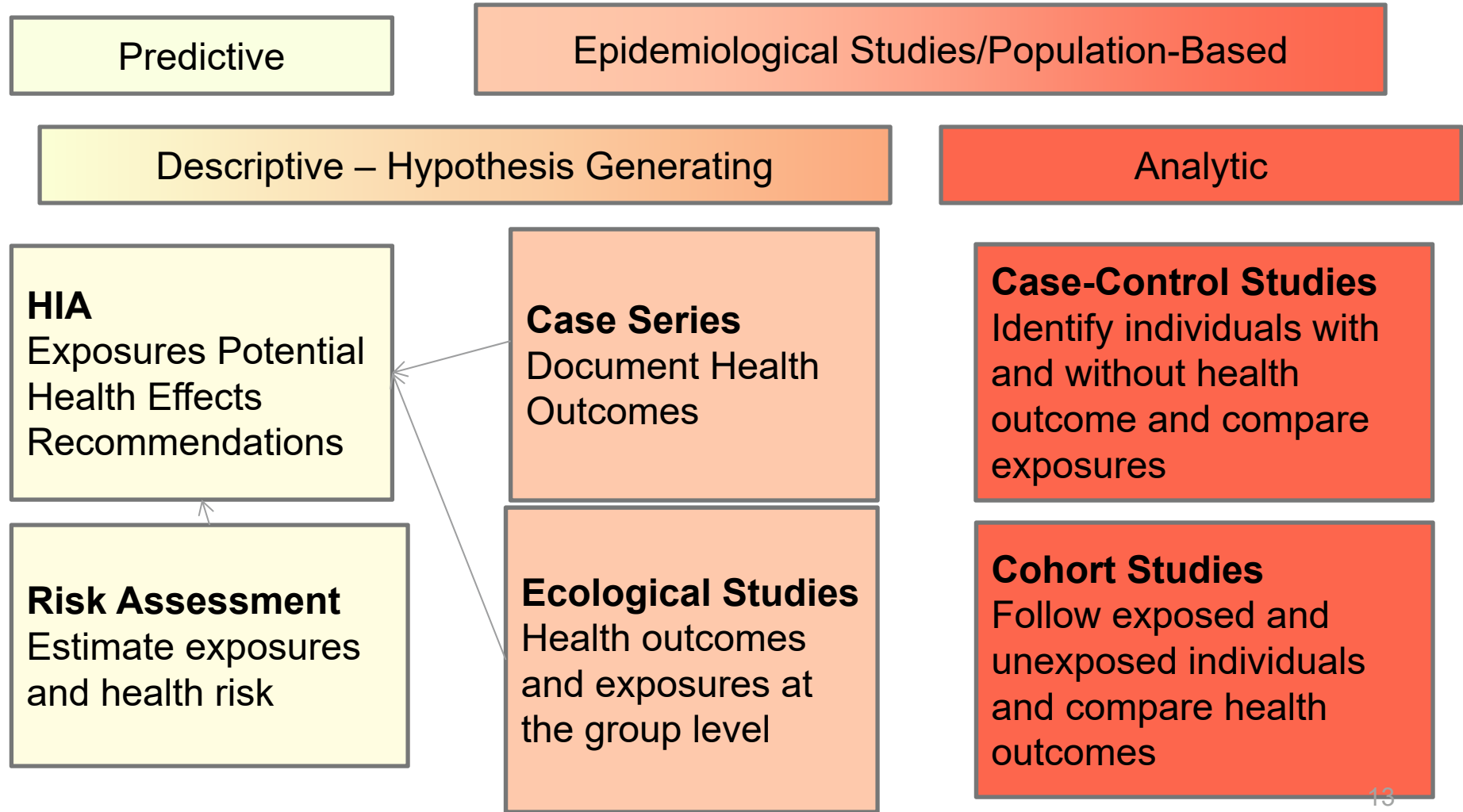
# Conclusions from ecological Studies

- Cases of childhood central nervous system cancers higher than expected in Pennsylvania shortly after hydraulic fracturing introduced (Frysek 2013)
- Cases of childhood leukemia not higher than expected in Pennsylvania shortly after hydraulic fracturing introduced (Frysek 2013)
- More cases of bladder and thyroid cancer than expected in Pennsylvania counties with shale gas activity (Finkel 2016)
- Cardiology and neurology hospitalizations increase with increasing density of wells in zip code (Jemielita 2015).

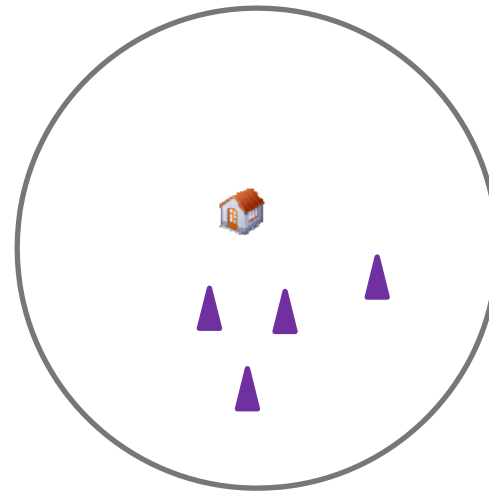
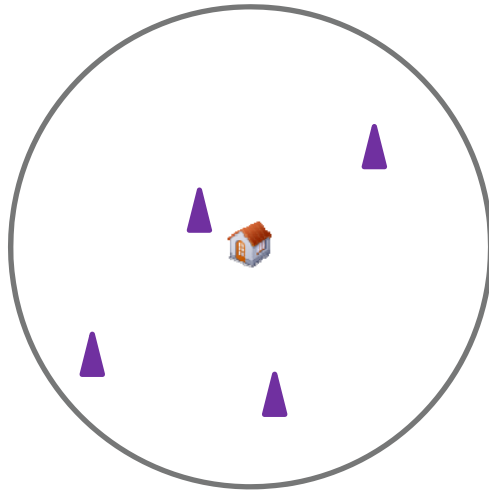
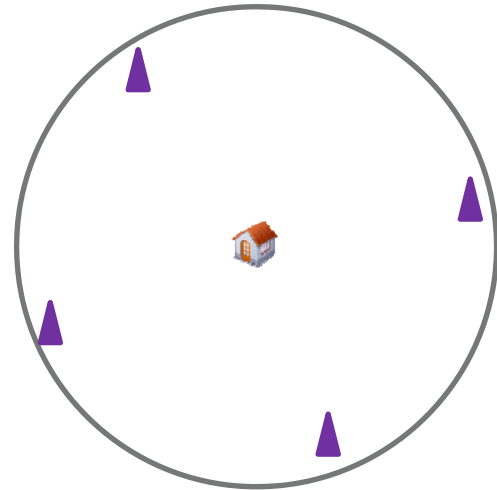
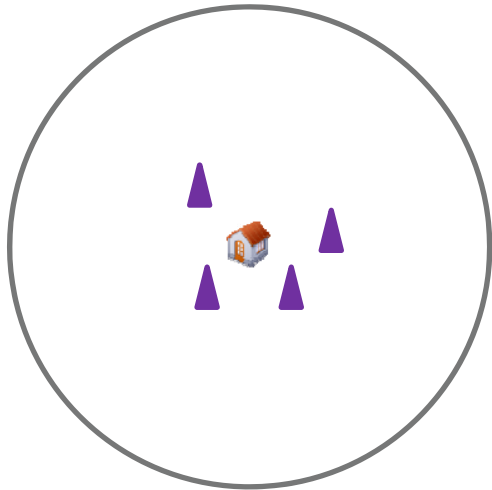
# Limitations of Ecologic studies



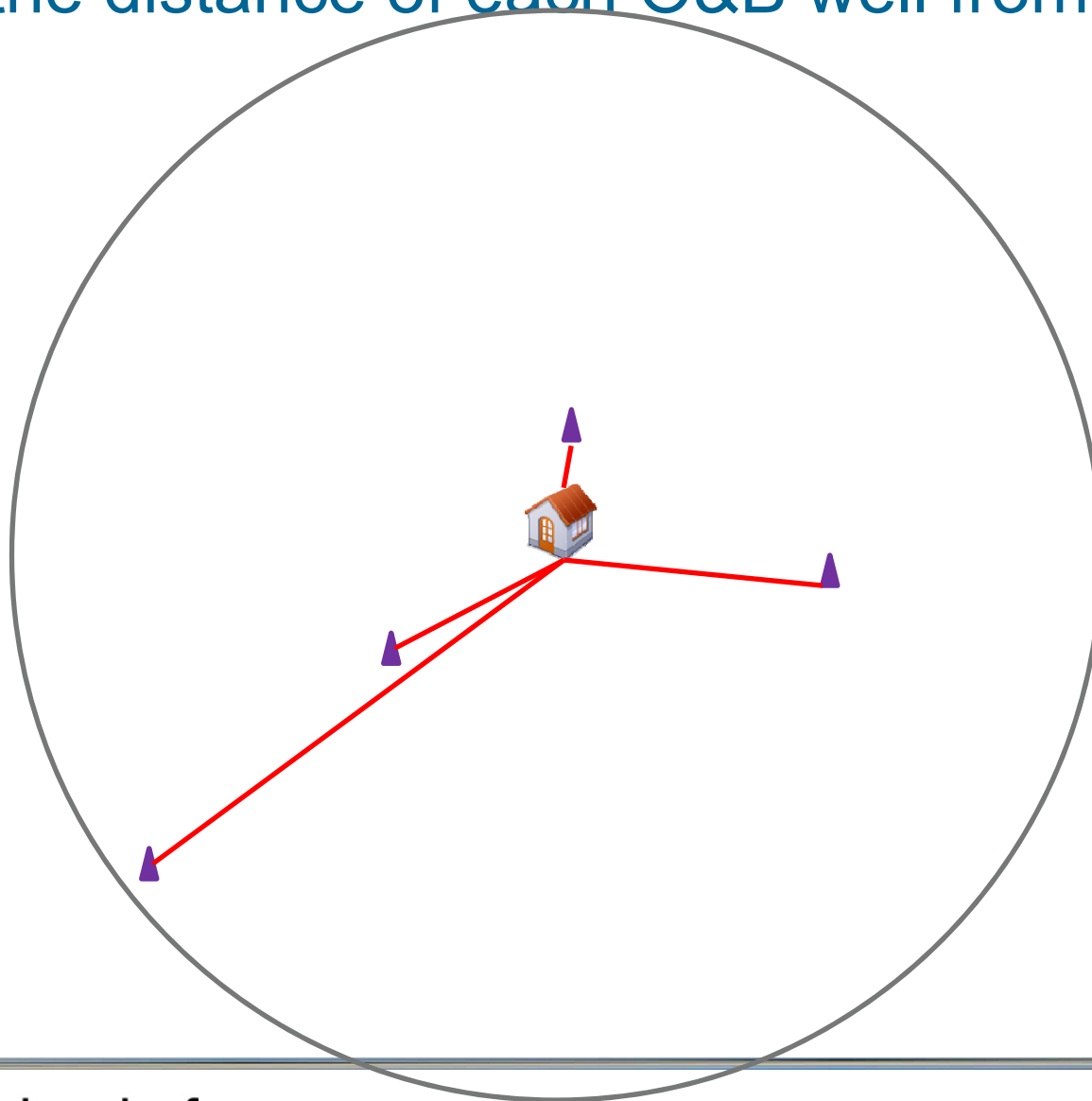
# Analytic: The Proximity Studies



# Location of the wells in relation to the home matters



Measure the distance of each O&B well from the home



# Inverse Distance Weighting (IDW)

*inverse distance =*

1

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*distance of well from mother's home*



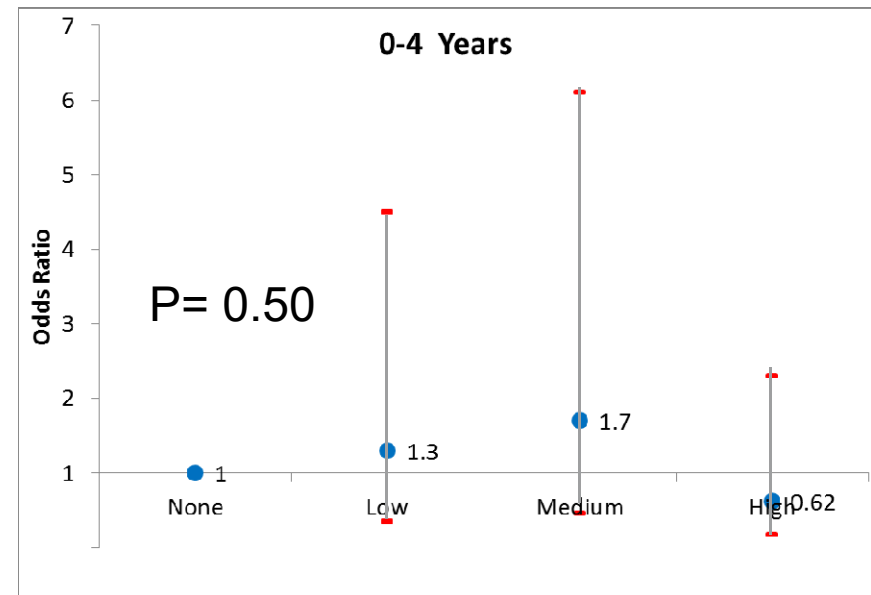
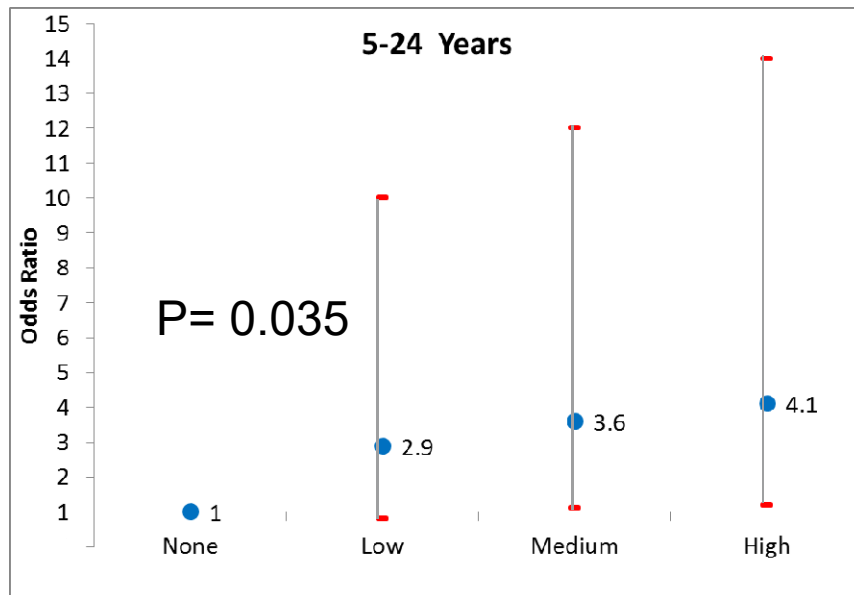
# Sum the inverse distances

- All wells 1 mile away:  $IDW = 1/1 + 1/1 + 1/1 + 1/1 = 4$
- All wells 5 miles away:  $IDW = 1/5 + 1/5 + 1/5 + 1/5 = 0.8$
- 2 wells 1 mile away, 2 wells 2 miles away =  $1/1 + 1/1 + 1/2 + 1/2 = 2.4$

# Proximity to oil and natural gas wells and childhood acute lymphocytic leukemia and non-Hodgkin lymphoma

- Registry-based case-control study
- 743 children from the Colorado Central Cancer Registry
  - Residing in rural Colorado
  - Diagnosed between 2001 and 2013
  - Age 0-24 years at time of diagnosis
  - Geo-coded address to rooftop accuracy
- 87 ALL Cases
- 50 NHL Cases
- 528 control: children with non-hematologic cancers
  - 78 children with another type of leukemia or Hodgkin lymphoma excluded

# More children with acute lymphocytic leukemia live in areas of high density oil and gas wells



low = first tertile, < 4.9 wells per mile, medium = second tertile, 4.9 to 33.6 wells per mile, high = third tertile, more than 33.6 wells per mile. Adjusted for age, race, gender, SES, and elevation.

McKenzie et al 2017

# Proximity studies other states

Health conditions more likely as proximity to UNGD wells/activity increases:

- Congenital heart defects and neural tube defects (McKenzie 2014)
- Low birth weight (Stacy et. al. 2015)
- Preterm birth and high risk pregnancy (Casey et. al. 2015)
- Asthma exacerbations (Rasmussen et. al. 2016)
- Nasal and sinus, migraine headache, and fatigue symptoms (Tustin et. al. 2016)

# What do these studies tell us?

- These studies show that there are more people with these health outcomes living near O&G wells.
- None of these studies show that living near O&G wells caused the health outcome.

# What the health studies do not tell us

- Baseline exposure: What were the concentrations of chemicals in air/water before O&G development?
- What actual exposures are:
  - What are people exposed to – if anything - and at what concentration/level?
  - Is O&G development the source of the exposures or is it something else?
  - If it is O&G, what activities are the source of the exposure?
  - Chemical stressors or non-chemical stressor?
- The distance O&G development should be to minimize potential for health effects
  - Likely no one “right” answer for this question
  - Highly dependent on activities

# Current Studies at the Colorado School of Public Health

- Follow-on study for congenital heart defects (American Heart Association)
- Cumulative risk assessment considering chemicals in air and water, noise, traffic, and accidents (National Science Foundation)
- Describing populations living near oil and gas development (National Science Foundation)
- Quality of life and subclinical biomarkers: comparing Greeley and Fort Collins Populations (National Institute of Environmental Health Sciences)
- Childhood Cancers (University of Colorado Cancer Center)

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